THE

FRESH-WATER AQUARIUM.

BY

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(i.e. Edward Step)

WITH TWENTY-NINE ILLUSTRATIONS.

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THE AQUARIUM.

CHAPTER I.

GENERAL PRINCIPLES.

AQUARIA, properly so-called, have a history extending back no further than forty years. True, as long ago as 1790, Sir John Dalyell had a collection of living marine animals in various tanks and glass jars, which he maintained at the cost of considerable labour; for, under his method, it was necessary for him to hire men to bring him up daily supplies of sea water in order to maintain life in his jars. His plan was to change the water every day—often twice a-day—by drawing off that contained in the jars and replenishing them by the daily supplies from the sea. Though this was, undoubtedly, the progenitor of the aquarium, yet it could hardly be considered as aquarium-keeping in the modern meaning of the term; for the principles which should guide all in the management of aquaria were ignored, or perhaps it would be more correct to say *unknown*. For an aquarium should be established and maintained on natural laws and principles, and to know what these are we cannot do better than observe the life

of a pond. Here we have a body of still water stocked with a number of fish, snails, beetles, and a large variety of other insects, all disporting themselves among a mimic forest of *water-plants*. Here there is no change in the water beyond what is caused by evaporation on the one hand and by rain on the other. Yet in a pond undisturbed by man the water is perfectly clear, and the denizens enjoy good health and prosper. Having such examples as the ponds before them, it is a wonder that naturalists did not earlier set up aquaria on scientific principles. But it was not until the year 1840 that these principles were practically seized hold of and adopted. About that date Dr. N. B. Ward published an account of his experiments with plants in close glass cases—the Wardian case now so extensively used for fern-culture. He also varied the arrangement by filling the case with water and placing therein living animals and plants. He had discovered the law of mutual support in creation, by which animals are dependent on plants and plants on animals. He was followed a few years after by Mr. Warington, Mr. P. H. Gosse, Drs. Bowerbank and Cotton, and Dr. E. Lancaster, whose successes induced the Zoological Society to erect an aquarium house in their gardens in Regent's Park. Of what, it may be asked, does this principle consist? A very simple fact in natural history, well known now to every school-boy, and yet ignored so thoroughly by those who kept aquaria, when it was fashionable so to do, and by many who aspire to an aquarium as a mere ornament. Animals in the process of respiration abstract oxygen gas from the air or water, and give off carbonic acid gas. On the other hand, plants absorb this carbonic acid gas, and by means of their chlorophyll are able to fix the carbon contained in

it, and set free the oxygen. So that, leaving all other points of dependence out of the question, animals could not long exist in an atmosphere unpurified by plants; neither could plants maintain a healthy existence if animals did not pollute the atmosphere with their carbonic exhalations.

If, then, this be a natural law, universal in its operation, it is easy to understand why live fish and other aquatic animals were kept with such difficulty when aquatic plants were entirely excluded from the tanks. It is still the fashion to keep tolerably large gold-fish in comparatively small glass globes, without an atom of water-weed, and consequently the water is soon robbed of its oxygen, and, therefore, rendered incapable of sustaining animal life. Under these circumstances it is necessary constantly to change the water, which also implies a continual change in the temperature surrounding the unlucky fish. The life of the poor creatures kept under such circumstances is most unnatural. Surrounded by a glare of light from all sides, with neither stones nor weeds under whose shade to rest, and with scarce room to turn round, they can but lie motionless at the bottom of the vessel, or make a weary endless pilgrimage round its circumference.

The aquarium-keeper should, above all things, strive to copy nature as far as possible. The light which penetrates the water should come from *above*, not from the side. There should be one or two corners in semi-darkness. There should be an abundance of fresh living plants. *The water should never be changed.* Care should be taken that the animals and plants are pretty equally balanced, and that all are in proportion to the bulk of water.

It is, of course, impossible to lay down any rule as to how many animals and plants should be allowed to an aquarium of a given size, or to a certain bulk of water, for the size and character of the animals and plants must be taken into consideration. This is a matter which a little practical experience will set at rest. An aquarium cannot be maintained as a mere toy any more than a garden can. It is easy to purchase large quantities of shrubs and flowers, and by arranging them tastefully in the ground secure an attractive garden,—for a time. But if those plants have been planted without due regard to their natural soil, situation, and the proper degree of dampness round their roots, the garden will soon become a desert. The same thing holds good with the aquarium. Neither can be started and maintained without a little thought, neither can be said to be well-established until some months after starting. But an aquarium when once fairly established requires little care—it is self-supporting.

CHAPTER II.

HOW TO MAKE IT.

THE much-quoted culinary recipe for jugged-hare insisted on the hare being obtained before proceeding further, but in the present case we must first obtain the vessel which is to become our aquarium. So long as the conditions insisted on in the preceding chapter are observed, the shape and size of the vessel is of minor importance. A successful aquarium can be maintained in a washing-tub, though for purposes of observation this form is not to be recommended. The same objection applies to large earthenware pans. But undoubtedly the best form for observation is a vessel of a more or less square or rectangular form, having one, two, or three transparent sides and an opaque back. Fig. 1 represents such a case, in which it will be observed the light would come from the top, that is, if the opaque back were turned towards the light. The depth should not be so great as the length, and the endeavour should be to offer a comparatively large surface to the purifying contact of the air. Regarding the materials of which the framework is constructed, there is considerable variety

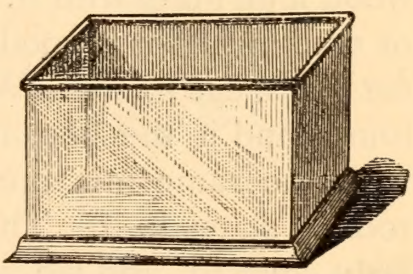

FIG. 1.

for choice. Some favour zinc, others slate, and others again stick to wood, but whatever is used, it is advisable to line the bottom and the opaque sides with slate. One of the simplest methods of constructing an aquarium is to obtain a good sound slab either of slate, or mahogany, or some other hard wood, of at least an inch in thickness. This should be grooved to receive the back and ends, which should be secured by screws from the under side. The ends and bottom must be likewise grooved to receive the plate-glass front, and the four sides strengthened and connected by a neat but strong mahogany rail round the top. The glass should be bedded in red-lead. Then the following mixture should be made: to three parts of pitch add one part of guttapercha, and melt over the fire, mixing well with a stick of wood. When sufficiently heated to stick, coat all joints and junctions between wood and glass with it. To protect this from chipping or cracking, it is a good plan to cover with thin strips of *hot* glass, cut to size. We have now perfectly water-tight joints, and if the bottom is of wood it is well to coat it with the same mixture, and whilst hot embed common roofing slates in it. The ends and back should be similarly covered, and we have at once a capital aquarium ready for use. Many variations of this plan will probably occur to the reader, these directions being merely offered as suggestions. For instance, it may be thought advisable to have the ends of glass, or not to line it with slate, but if an aquarium be constructed as we have suggested, it will be a lasting one. The framework may be constructed, as we have said, of zinc, but the soldering process is not so easily performed by the amateur, and after all the aquarium is not so strong.

If it is considered advisable to have a fountain there

can be no objection to it; on the contrary, it is beneficial, as helping to purify the water, though if there is a sufficient quantity of growing vegetation, it is not needed except as an ornament. But if the fountain be adopted it must be arranged on the lines laid down in the previous chapter, viz.—*the water should never be changed.* Fig. 2 will explain how a fountain may be obtained without violating this rule. *C* is a small cistern placed at a proper height to give the requisite fall to the water. To the cistern is attached the feed-pipe (*fp*) which supplies the fountain. *O* is the overflow pipe, which empties into a pail or other vessel placed beneath the aquarium stand. Now, in starting the aquarium, it should be filled with water up to the top of the overflow, and the cistern should also be filled, and the fountain turned on. As the water rises it will flow over into the pail beneath, which should be emptied again into the cistern, not thrown away. By this plan, although the water is in constant circulation, it is never changed.

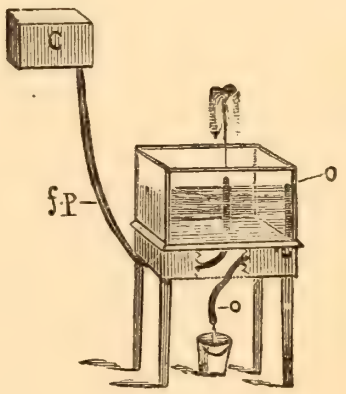

FIG. 2.

And now that we have got our aquarium, with what water shall we fill it? Not that supplied by the water companies. Water taken from a stream or river is the best, or rain-water will do if it has been caught in a clean vessel. Pond water is also good. Having filled up the aquarium with water, the plants should be placed in it, and then left for a week at least, before placing the animals

in. The floor of the tank should be covered with carefully washed gravel, and some rock-work should be so arranged, by cementing, as to afford a small spot of dry ground for such inhabitants as require it. Before taking leave of this part of our subject, we would observe that where there is a fountain, the receptacle for the overflow water should be as large as possible.

CHAPTER III.

THE FRESH-WATER AQUARIUM.

THE first thing to consider after getting the water into our aquarium, and having ascertained that it is free from leakages, is the stocking it with plants. The most valuable kind of vegetation we can have in the tank is the microscopic algæ. We cannot obtain this at once, but must wait a little time for its development on the stones and walls of the tank, from the spores floating in the pond or river-water we have introduced. It will first appear as a slight green scum on the surfaces of things, and when well developed will present a beautifully jewelled appearance as the delicate filaments become beaded with tiny bubbles of pure oxygen which glisten like little diamonds. Hosts of tiny creatures (described further on) will make this algæ their home, and these in turn will form a food supply for the larger animals. The larger plants may be planted in the gravel, covering sufficient of the stalk to prevent the plant floating on the surface. For this purpose, young healthy plants should be selected. Of the species most suitable for the aquarium we may select one or more of the following:—The American Pondweed (*Anacharis alsinastrum*), the Water Starwort (*Callitriche verna*), the Pondweeds (*Potamogeton natans*, *P. densus*, *P. crispus*, *&c.*),the Water Crowfoot (*Ranunculus aquatilis*), the Frogbit (*Hydrocharis morsus ranæ*).

It must not be inferred that we advise the introduction of all these species into one aquarium; two or three species is sufficient. Of these, one species chosen should have floating leaves, to afford cool shade for the fishes, &c. The first named of these, the American Pondweed, is a very rapid grower, and the smallest piece of it will develop roots and quickly attain a considerable length. It consists of a long brittle stem upon which the bright green leaves are arranged in whorls of threes, as in Fig. 4*b*. It is to be found in almost every pond and stream in the kingdom. A somewhat similar but less robust-looking species is the Water Starwort (*Callitriche verna*), in which the stem is more sparsely clothed with leaves, and at the growing extremity the leaves form a flat star-like head, from which the plant derives its popular name. The Water Crowfoot is one of the buttercup family, but its flowers are white, the petals tinted with yellow near the centre of the flower. It is a tolerably robust species, and, as its flowers are floating ones, presents a very pretty appearance. The Frogbit is desirable on account of its floating heart-shaped leaves, which afford a little shade to various of the inhabitants. One of the most favourite plants for the aquarium is the *Vallisneria spiralis*, a plant not found wild in England, but easily to be obtained from any of the dealers in aquarium requisites.

FIG. 3.
The Frogbit.

Our next consideration is the finny denizens of our mimic pond. Before deciding what fish we are to introduce, we must settle whether the water is to be

stagnant or constantly circulating, for many fish whose habitat is running streams cannot maintain a healthy existence in a pool of still water. There are, however, some species which are not so particular, and make themselves perfectly at home either in still or running water. Among these is the Eel, and if young healthy specimens be selected, they live for a great number of years and give very little trouble. Those adopted should be small specimens with a circumference about equal to that of an ordinary lead pencil. They may be obtained of the dealers under the name of Silver Eels, and their easy graceful movements will obtain for them much attention. They are exceedingly slow in attaining size, in which respect they differ considerably from Bream, which increase in size very rapidly. These latter may well be kept in a large aquarium with still water, their natural habitat being muddy ponds and lakes and the placid deeps of sluggish rivers. Being very timid fish, some dark shelter should be provided for them in which to hide. Far more suitable, however, is the Common Carp, which cannot be equalled for hardiness. Always a favourite in aquaria, it is a fish that can be depended upon. Small specimens are the best and most interesting, more interesting than its relative the Golden Carp, which is kept chiefly on account of its gay colours. Both the

FIG. 4.

(*a*) *Vallisneria*; (*b*) *Anacharis*.

species are principally vegetable feeders, for whom an

FIG. 5.—Bream.

abundance of growing weeds should be provided; but

they will not object to an occasional tit-bit in the shape of a small worm.

Another excellent member of the Carp family is the

FIG. 6.—Tench.

Tench, an inhabitant of pools and quiet streams where there is scarcely any current. It delights to bask under the leaves of the water-lilies during the hot summer weather, and in an aquarium needs a quiet

corner for retirement. It attains the length of about a foot.

The Perch is a noble-looking fish to introduce into a large aquarium, but its great voracity necessitates care being taken to have only small specimens. It should be well fed with worms and insects to prevent its disposal of smaller fish.

Undoubtedly one of the best fish for aquaria is the Minnow, although its natural habitat is running streams. Being of a very active nature its movements are a source of great interest, whilst the clear white of the lower half of its body contrasting well with the olive hues of its back gives it a pleasing appearance. After being in the aquarium for a short time this fish loses whatever timidity it may have possessed in its native streams, and will willingly eat from the hand.

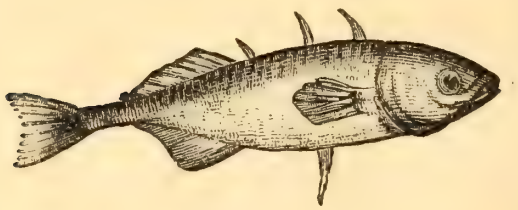

FIG. 7.
Stickleback.

More interesting perhaps than any other species is the common Stickleback of every pond and stream. We confess that this fish has long been our favourite in the aquarium. It is probably the first subject in the aquarium-keeper's experience. Most persons can date their start in aquarium-keeping from the time when, as youngsters, they sallied forth to the nearest pond, armed with a stick, a length of cotton, a few worms, and a pickle-bottle,—the tackle required in the capture of this pluckiest of all fish. For courage and daring it is unrivalled. It has been credited with attacking and destroying fishes five or six times its own size, running at them and ripping them up with its sharp spines. On

account of these combative proclivities it should be kept by itself—that is, so far as other species of fish are concerned. But if it be the only finny denizen of our artificial pond, its interesting habits and movements will more than repay for the lack of variety in species. The juvenile angler calls the male fish a "red-throat," on account of the rich tints of crimson and green he assumes in spring-time. At this period the pugnacity of the species is exhibited in a very marked degree. Curiously enough, it is the habit of Sticklebacks to construct nests for the proper protection of their eggs during the period which elapses between laying and hatching. This nest is constructed of weeds and grass, somewhat tubular, open at both ends. In this a large number of eggs are deposited, and it becomes the duty of Mr. Red-throat to guard this nursery from the depredations of his kindred. It must be conceded that he discharges the duties of his trust faithfully, for presently we observe a marauder prowling about in search of dainties in the shape of Sticklebacks' eggs. The guardian of the nest prepares for action, and elevating his back spines and sticking out those on his sides, rushes upon the intruder. The battle has now commenced in earnest and continues to rage until one falls lifeless to the bottom, his belly ripped open by his adversary's sharp spines. Sometimes, however, it does not terminate so fatally. One of the combatants feeling that the battle is not with him, and that "discretion is the better part of valour," slinks off, a sadder and a wiser fish, but "lives to fight another day." A small worm dropped into the vessel containing these fish will afford considerable amusement. It will be quickly seized by one individual who will rush to the other end of the tank with it, followed closely by a pack of his relatives,

who seek to rob him of his meal. Three or four fish will seize it at once, and the excitement that ensues as each pulls in a different direction is most amusing to the spectator.

As an instance of their extreme hardihood we may mention that we have kept a number of them in a tank in the open air, exposed to all weathers. This fact in itself is of little importance, for in ponds they are exposed to similar conditions. But there is this difference. In the deep waters of the ponds they can swim freely below the ice in the hardest winter, but in our tank during the Arctic weather of the past winter (1881) the water was frozen into a solid block of ice. Whether the fish found a small unfrozen cavity at the bottom, or whether they were frozen up in the ice, we cannot say, but we had given up all hopes of seeing them alive again. On the third day after the thaw we visited the tank, and found that only about half-an-inch all round the block had melted. The fish had found their way into the open channel thus formed, and thence on the surface of the block, which was covered by about one-eighth of an inch of water. In this the fish, almost worn out, were kicking and struggling on their sides, unable to get back to the deeper channel. We removed some of them to an indoor aquarium, where they soon exhibited the greatest liveliness, and have not since shown any evil results arising from the freezing process they must have undergone.

The foregoing species may all be kept with tolerable success in still water, but if the aquarium-keeper would have Dace, Roach, or Gudgeon, he must have a stream of constantly-flowing water. They are inhabitants of swift-flowing streams, and cannot brook the stillness of

the pond. To meet the requirements of this species, it is

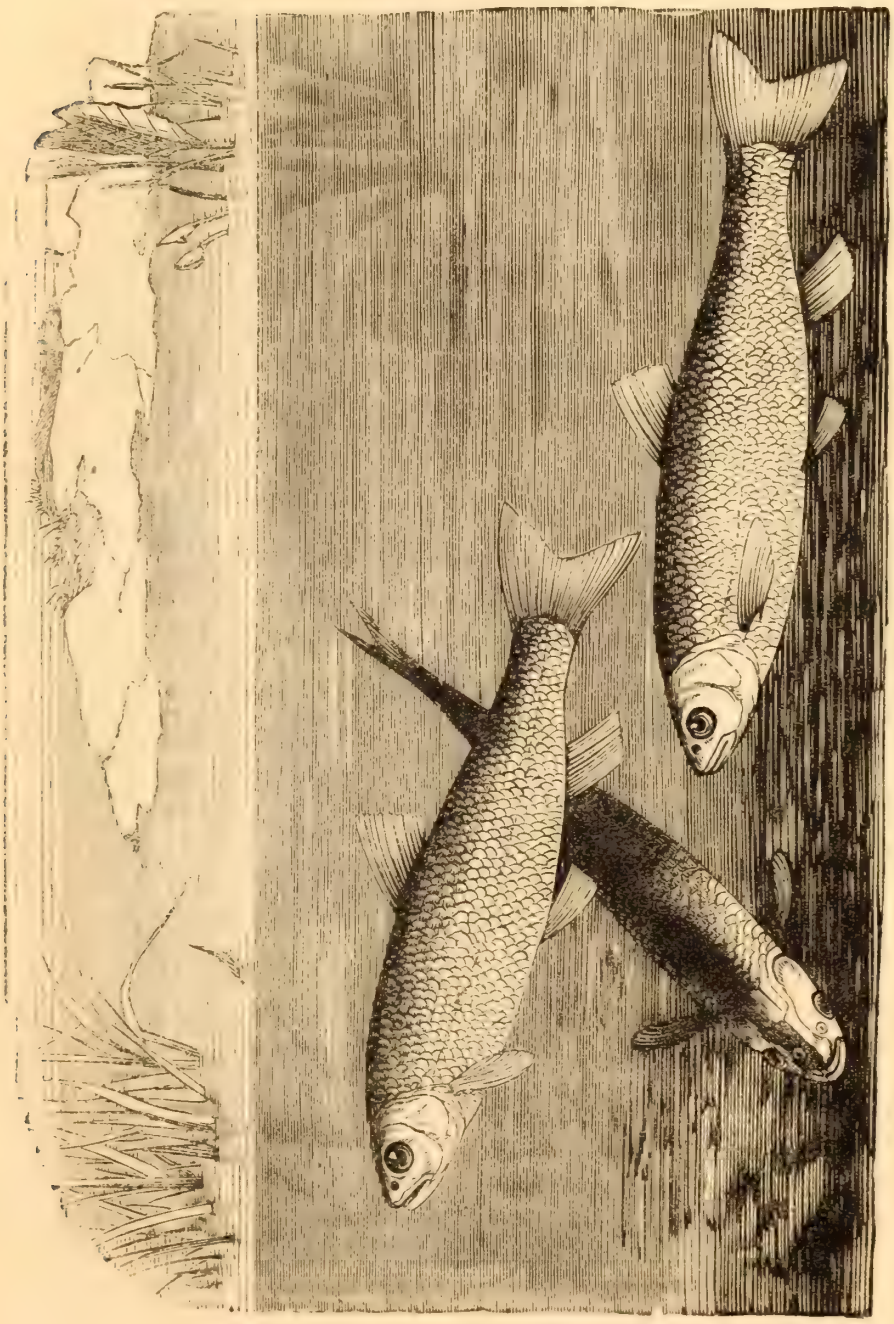

FIG. 8.—Dace

therefore necessary to have a fountain, with not too fine a jet, constantly playing.

These fish will, of course, require to be fed. Some of

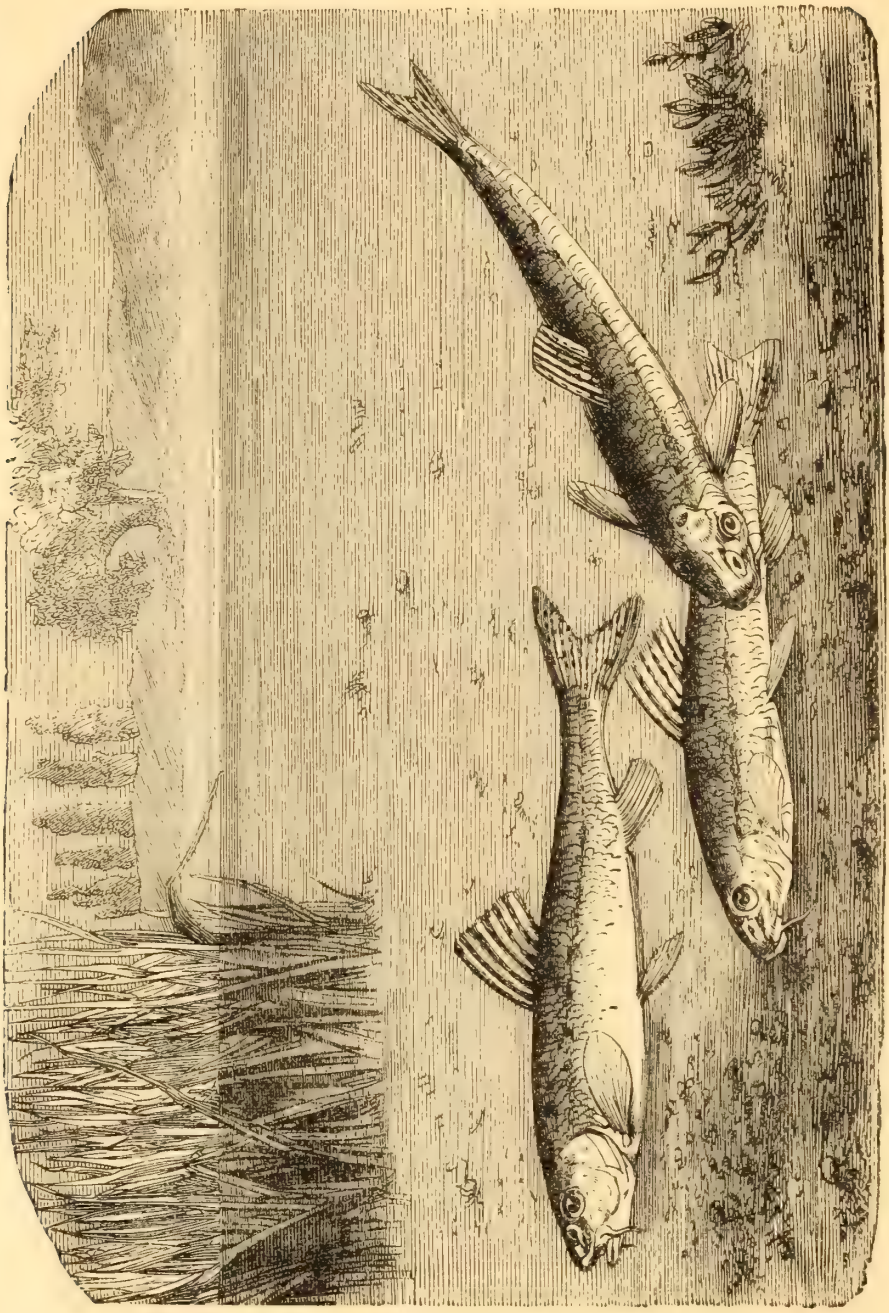

FIG. 9.—Gudgeon

their food they will obtain from the plants with which we have stocked our tanks, but we shall need to supple-

ment it by giving them small worms—blood-worms do admirably—flies, and other insects. Some of the dealers supply the pupæ of ants for this purpose under the appellation of "ants' eggs."

But there are animals even higher in the scale of organisation than the fishes suitable for the aquarium. We allude to the Newts, of which two species inhabit our ponds. In spite of the bad character these perfectly inoffensive creatures have obtained, they will be found a great addition to the attractiveness of the aquarium. The smallest and most common species is the Smooth Newt (*Lissotriton punctatus*), a pretty little fellow with olive-coloured back and legs, orange spotted with black beneath. During spring the male is ornamented with a fine frill, which extends from the back of the head and all along the back to the tip of the tail. But greatly exceeding it in beauty is the Great Warty Newt, a plentiful species, but not so common as its smaller congener. In this species the frill is very deep and repeatedly notched. They should be fed with worms.

The development of these interesting creatures can be easily watched, for they breed freely in the aquarium. The female lays her eggs singly, attaching them to the leaves of *Anacharis*, *Callitriche*, or *Potamogeton*, and folding the leaf over the egg. In that position the leaf remains, for it is glued to the egg by an insoluble cement. And well the egg requires the protection, for hungry fish are always on the look-out for such delicacies. In due course the eggs will hatch out, and as the result we shall have a number of little creatures similar in form to a small "tadpole." Respiration is carried on in these by means of gills, or external *branchiæ*, but as they

acquire limbs so the gills are absorbed, and they become minature *replicas* of their parents. The eggs of these creatures afford a capital study in embryology, for the enveloping membrane is so clear that all the stages of development may be clearly seen by the aid of a good lens.

Newts may be purchased of the dealers in aquaria, or what is much better, sought for in ponds; but, when introduced into the tank, provision should be made to enable them to quit the water for a time when they are desirous of so doing, for it must be remembered that they are amphibious animals. It will also be necessary to prevent their climbing out of the tank. This may be effected by fastening strips of glass or perforated zinc flat on the top-rail of the framework, so that they overhang for about two inches inside.

FIG. 10.

Planorbis corneus.

Molluscs are very useful in the aquarium, provided that care is taken in the selection of species, and that too many specimens are not introduced. They are vegetable feeders, and materially assist in checking the otherwise too-rapid growth of *confervæ* on the glasses. If the specimens are too large or too numerous, however, they will check it altogether.

The best species to select from are the following:— *Lymnæa peregra*, *Planorbis corneus*, *Planorbis marginatus*, *Bithynia tentaculata*, and *Cyclas cornea*. For large tanks *Lymnæa stagnalis* may also be used, but in small structures its appetite is too great to allow the plants a chance of increase; it has also a fondness for animal substances. *Planorbis corneus* is popularly known as the Trumpet Snail, and mostly in demand for aquaria. *Planorbis marginatus* is less known, though equally common. It has a very

thin, flat shell, through which the organs of the mollusc may be viewed. *Lymnæa peregra* is exceedingly common in most ponds, and its eggs will afford another embryological study. *Bithynia tentaculata* closes its shell with a horny valve (*operculum*), like the "eye" of the periwinkle. It is depicted on Fig. 11, *d*. The female lays her eggs in bands of three rows, very carefully cleaning the surface on which she is about to deposit them. These bands contain from thirty to seventy eggs, which hatch in about three weeks or a month. The young snails are two years in attaining their full growth. One of the most interesting small molluscs is a tiny bivalve, that may well be called the Fresh-water Cockle, shown in Fig. 11, *a*. The projections from within are the "foot" and the "siphons." With the first of these appendages it digs into mud or sand, and climbs up the water-weeds. Through its siphons the respiratory process is carried on. Its shell is exceedingly thin, and through it the motions of heart and gills may be seen distinctly. The animal is what is termed ovoviviparous, that is to say, it carries its eggs about in its gills until they are hatched. The River Snail (*Paludina vivipara*) is a large species allied to *Bithynia*, found in profusion in the Surrey Canal. It is truly *viviparous*—that is, it does not produce eggs, but living young.

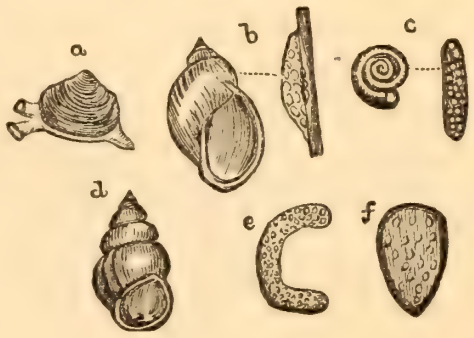

FIG. 11.

(*a*) *Cyclas cornea*; (*b*) *Lymnæa peregra* and Spawn; (*c*) *Planorbis vortex* and Spawn; (*d*) *Bithynia tentaculata*; (*e*) Spawn of *Lymnæa stagnalis*; (*f*) Spawn of *Planorbis corneus*.

CHAPTER IV.

THE INSECT AQUARIUM.

THE aquarium-keeper who is an entomologist, or who wishes to obtain a practical knowledge of insect life, may devote a portion of his time to rearing aquatic insects, or such species as are aquatic during a portion of their lives. But there is a difficulty in the fact that most of these aquatic insects are carnivorous in their habits, and must be fed with living food, or they will consume each other, and this cannibalism is sure to be carried on to some extent even where they are provided with plenty of more legitimate prey.

A little dredging in a pond, with a strong canvas net, will produce a number of aquatic insects of various species. Among these will be some strange-looking active creatures, with long bodies, six long legs, and a pair of apparently aborted wings on its back. These are the larvæ of Dragon-flies, vulgarly and erroneously styled "Horse-stingers." They inhabit the water for several years, and then the wings develop, the old skin bursts, and they have left the watery element for ever, to fly over the ponds they had previously dwelt in. In the perfect state they are among the most beautiful, as they are among the most terrible of the insect tribes,—terrible that is, so far as other insects are concerned. For it is the nature of this fleet-winged, steel-mailed creature to dart

like "a living flash of light" after the less powerful butterfly, and seizing it in its fore legs, nip off the wings and devour the tender body. In their aquatic or larval condition, they are equally ravenous. They wander over the mud of the bottom, often covering their bodies with that substance, in order that they may more easily approach their prey without observation. Their usual mode of progression is very remarkable. The insect obtains its supply of oxygen by drawing in a quantity of water through an opening or valve in the last segment of its body. This water is brought into contact with the respiratory apparatus, by which the oxygen is extracted, and, should the insect wish to move forward, the valve is opened and the water ejected in a powerful jet. The whole force reacts upon the insect with the result of propelling it forward.

FIG. 12.

Dragon-fly.

Should it desire to capture another insect, or a very small fish, it lies quietly in wait, perhaps buried, except the head, in the mud. A movement of the body might betray it, but it waits until its prey is near, and then its head seems suddenly to leave the body, dart after the unsuspecting victim, and seize it in the terrible jaws. As a matter of fact, it is literally "two-faced." We often hear deceitful people spoken of as being "two-faced," but only in a metaphorical sense. Here we have the reality, and the two faces are used

for deceit too. By a peculiar process of development the lower jaws become converted into a mask provided with a pair of pincers. This mask is attached to a long jointed rod, by means of which it can be shot out some distance from the head, and, when the prey has been secured by the pincers, as quickly drawn back to the insect's mouth. As we have before stated they are exceedingly ravenous, and must be carefully looked after, as they will attack and destroy young newts, if they have the opportunity. But there is so much of interest attached to them, that any trouble incurred in keeping them will be fully repaid.

Another group of insects inhabiting the water in their early stages are known as Caddis-flies. Interesting as the Dragon-fly larva is from its peculiar structure, the Caddis-worm is perhaps more so, from its defenceless nature. It has no powerful jaws, no special locomotive apparatus, not even the tough integument in which the Dragon-fly larva is encased. The Caddis-worm is totally unprotected by nature, and its skin is of the very tenderest description. But to remedy nature's oversight, our little friend constructs itself a movable grotto impervious to the attacks of inquisitive fish. This protection takes the form of a cylinder, perfectly smooth within, and lined with a dainty tapestry of silk, but without it is of the roughest description. To make it they collect little gravel-grains, small snail-shells, bits of wood, leaves, &c., and fasten them together by an insoluble glue. Different species exhibit special preferences in regard to building material. Thus *Anabolia nervosa* prefers coarsest grains of sand for the construction of its tube, but it is always lightened by a miniature log of wood running along the upper surface, and overlapping in front, so that the tenant can put out

his head and legs for purposes of locomotion or reconnaissance. Various species of *Limnophilus* construct more robust-looking cases of twigs of wood cut up into suitable lengths, of pebbles, of the shells of *Planorbis vortex* and *marginatus*,—some of these shells empty; but very frequently they lay hold of shells still occupied by living snails, whilst another species selects portions of grass stems, which are so arranged as to bristle out at every point, like a little Sea-urchin. Some persons have experimented with them, by taking them out of their "cases" and placing them in a vessel of water containing only fragments of coal, coloured glass, &c. The insect soon constructs a new case which, of course, contrast with those obtained from pond or stream. In the Geological Museum, Jermyn Street, London, are several specimens made entirely of quartz, taken from a stream whose floor consisted of that mineral. The "flies" which result by development from these Caddis-worms, are exceedingly pretty little creatures, with very delicate gauzy wings, usually of a sombre hue, but occasionally beautifully iridescent. On emerging from the watery element, they will probably seek the window-curtains as affording a safe foot-hold until their integuments have hardened, and their wings expanded. They will often hover about the aquarium for the greater part of their winged existence, and sometimes deposit their eggs therein.

We must not forget the Water-beetles, of which a large variety may be obtained from any pond. The largest British species, and the most desirable for keeping with other species, is the Large Water-beetle (*Hydrophilus piceus*). Unlike most other water-beetles it is not predatory, and can therefore be trusted in the same tank as the fish. Its body is black, the breast covered by a

yellowish down. The female covers her eggs up in a silken bag which floats upon the surface until the eggs hatch.

Of a far different character is the Great Water-beetle (*Dyticus marginalis*), of which a figure is given. It is about an inch in length. In this species there is considerable difference in the appearance of the male and the female. The male is represented in the annexed figure, and its wing-cases, or elytra, are *smooth*, whilst those of the female are deeply furrowed. In addition, the male has a different formation of the fore-legs, a portion being flattened out into a cushion bearing suckers on its under surface. Throughout its life this beetle is equally voracious, for the larva in an aquarium is as destructive as a tiger would be in a sheep-fold. It has a long, narrow, flexible body, and its head is furnished with a couple of sharp, curved jaws, which move over each other like the blades of a pair of shears. These jaws are hollow, and when they have pierced an enemy its blood is sucked through them.

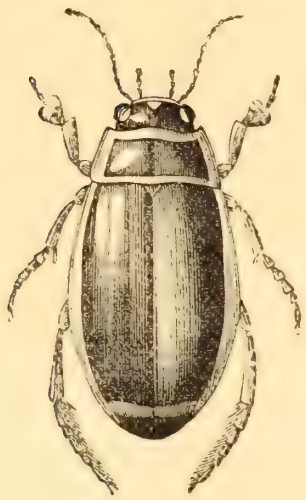

FIG. 13.
Dyticus marginalis.

It is impossible for us, in the necessarily restricted space at our disposal, to enter into a description of the various species of water-beetles, but they will all be found to possess a considerable amount of interest if kept in a special vessel. There is a common species known as *Acilius sulcatus*, with rather flat, brown wing-cases, deeply furrowed longitudinally. There are the various species of *Hydrophilous* and of *Agabus*. Nor should we forget the

merry little Whirligigs (*Gyrinus*), which are always to be seen on the surface of ponds, when the sun is shining, whirling round in circles and curves, their highly polished integument reflecting the sunshine, like diamonds. Note the peculiar structure of the eyes, apparently divided into four to enable the insect to see above and below the water, as its usual habitat is the surface of the water. Another pretty little species, *Hyphidrus ovatus*, is represented in Fig. 14, much enlarged, its actual length being about one-sixth of an inch. Its colour is reddish-brown, and it is pretty plentiful in most ponds. Fig. 15 represents *Ilybius ater*, a species somewhat similiar in form to *Dyticus*, but smaller. It is equally common.

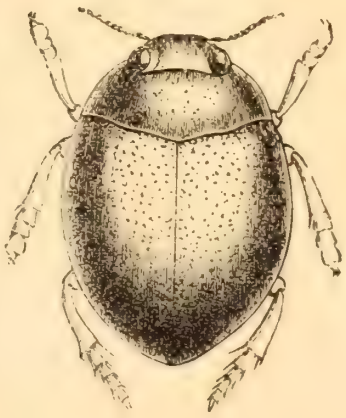

FIG. 14.
Hyphidrus ovatus.

All these species, and others beside, may be kept in an insect aquarium, but care should be taken to keep the vessel covered, either with a plate of glass, or a piece of gauze; else these beetles will at night leave the water and fly about the house. If they are allowed to do this they are almost sure to come to an untimely end under the idea that they are "nasty, horrid, black beetles."

FIG. 15.
Ilybius ater.

Very interesting subjects may be found in the various species of Gnats, which exist in water, during the early stages of their life. The female Gnat stands upon a float-

ing leaf or other available platform, and with the last pair of legs crossed to form an angle, she lays her eggs between them. They adhere together, and when all are laid assume the form of a little boat. Each of these boats contains about 300 eggs, and floats safely, in spite of the breezes that agitate the waters. When the eggs hatch the resultant larvæ find themselves in the element proper for their early life. They are exceedingly strange-looking insects, and wriggle through the water with considerable activity, occasionally coming to the surface for air. A remarkable point of structure here comes into play. Near the tail end of the insect a tube is given off at a considerable angle. When the larva wishes a supply of fresh air it seeks the surface, and there floats, head downwards, with this tube protruding into the upper air. Through this tube the fresh supply is taken in. The pupa is as grotesque as the larva, and progresses through the water by coiling itself up and suddenly uncoiling. When arrived at the proper stage, the pupa floats along the surface on its back, and by an effort splits its skin sufficiently to enable the perfect insect to escape. By this process the pupa-skin becomes converted into a boat, of the most fragile nature, and it requires very careful management on the part of the gnat to prevent a wreck. After its wings have sufficiently expanded and acquired the requisite degree of hardness, it essays to try them in flight. The empty pupa-skin may now be secured by carefully slipping a piece of clean white paper, or card, beneath it and gently raising it out of the water. If allowed to dry on the paper it will need no other preparation.

Some of the Water-bugs might also be admitted to our insect pond. The well-known Water Boatman

(*Notonecta glauca*) is one of the most interesting, and for oddity of form the flat Water Scorpion (*Nepa cinerea*), the strawlike Water Measurer (*Ranatra linearis*) and the active *Gerris*. In addition there are two other species of Diptera,—the Hoverer flies and the Crane flies (Daddy Long-legs). The larva of the Hoverer fly (*Eristalis*) is known as the Rat-tailed Maggot, and inhabits the mud of ponds and water-butts. The Crane fly larva is known as the "blood-worm," and is a favourite food for fish.

In the insect aquarium may also be included several species of minute Crustaceans,—the Water-fleas. Under this name are included three species at least,—Daphnia, Cypris, and Cyclops. They are very minute creatures, and, like their larger relatives, cased in plates of mail. They are very active and equally prolific. In fact, it has been estimated that the progeny of a single female *Daphnia* may amount during her lifetime to the enormous number of four billions and a-half, which would weigh in the aggregate nearly eight tons. It is this astonishing rate of increase that renders them useful occupants of the fish-tank, for they form no inconsiderable portion of the fishes' food.

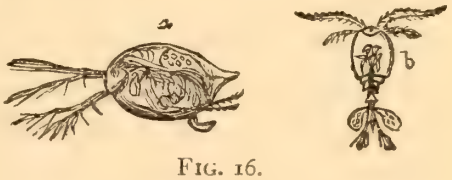

FIG. 16.
Water-Fleas.

It must, of course, be understood that an abundant supply of vegetation is required in the insect tank, and it will be necessary to treat the inmates to a dead fish occasionally.

CHAPTER V.

THE MICROSCOPICAL AQUARIUM.

THE tank for microscopic objects should be square. The round bell-glasses or globes prevent accurate observation by distorting the objects. It is better, too, to have both front and back of glass, and the vessel, when once placed in a suitable position, should not be shifted. The vessel should not, of course, be so large as that used for fish, and the position adopted should be a north or north-east window. A writer in *Science Gossip*, under the initials "E. D.," gives such practical advice on this subject that we cannot forbear quoting some of his remarks. He says :—

"Anything approaching the idea to make it 'pretty,' should be studiously avoided: nothing should be included but with the object of use; the more useful, the more beautiful it will be; two pieces of goodly-sized stone or irregularly-shaped brick should be placed nearly touching the front glass; these stones soon become covered with organisms, and may be so adjusted as to be within range of an ordinary magnifying lens. Two or three plants (not more) of Vallisneria, or Chara, are to be planted in *one corner* in well washed gravel, banked up with one of the pieces of stone; the other part of the floor of the tank should be left bare, to facilitate the picking up, free of sand or gravel, of anything that may appear. If a

pond be accessible, three parts of the tank are filled with water from it; if it be cloudy or even muddy, the result may be more favourable. After being left in repose for at least a week, the character of the contents (if the pond be fairly productive) will be seen; the water will be clear and probably reveal a variety of common objects, such as larva of insects, entomostraca, planaria, and hydræ; in a week or more vegetable growth will appear, covering every portion of the interior. The tank is now in a condition to be inoculated with whatever choice objects can be obtained, the result of special and favourable gatherings, and this should be repeated frequently; the front glass must be occasionally cleaned with a sponge tied to the end of a cane, but on no account be tempted to touch the sides or back: the water will soon become as clear as crystal, however muddy it may have been when first introduced. The pieces of stone will show signs of vegetable growth, with patches of such forms of infusoria as vorticella and stentors. The waste from evaporation must be supplied by additions of pond water (the richer the better), and such a tank will be, in a month or two, (not before), a marvel of microscopic beauty and interest. The untouched back glass will be covered with a dense mantle of dark-green velvety vegetation, in the midst of which will be discovered groups and patches of the fixed infusoria, and it is essentially the habitat of the polyzoa; hydræ, and the rarer rotifer philodina, even melicerta, and stephanoceros, may be found under such circumstances, to say nothing of the countless tribes of free infusoria, ever ready for observation in all their various phases of existence, and such conditions will preserve and increase them indefinitely. Enemies to eliminate are larvæ of insects (but these soon disappear naturally),

the fluviatile arachnidæ, and the larger molluscs; the latter in browsing through the vegetation on the glass are apt to destroy perhaps a favourite group of stentors."

Among the plants introduced in this manner will probably be included several species of the filamentous algæ, such as Zygnæma, and Oscillatoria of which illustrations are given.

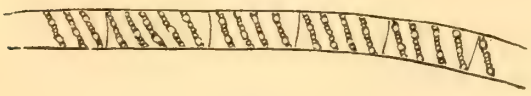

FIG. 17.
Zygnæma.

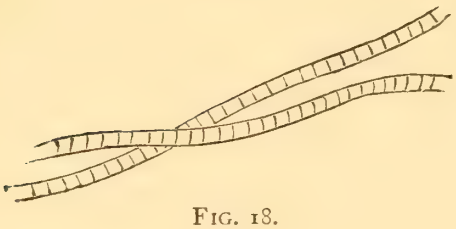

FIG. 18.
Oscillatoria.

We may be fortunate enough to get a few specimens of the lovely Volvox, but it will be difficult to preserve them in our tank for any length of time Whilst we have it though, we may enjoy a good examination of it. It continually revolves by the aid of the *cilia* with which its surface is studded, and within the young volvoces may be seen to revolve similarly. They are frequently to be found in ponds, often in very great profusion. Other locomotive plants you are sure to obtain are the Euglenæ,—little bright-green bodies with a bright red spot like a gleaming eye at one end of it. But it is perhaps among the Desmids and Diatoms that we shall find the most beautiful forms of microscopic plant-life.

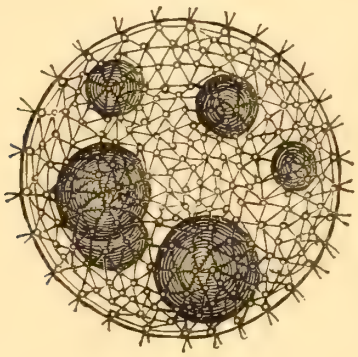

FIG. 19.
Volvox.

Such are the Cosmarium, Closterium, Pediastrum, and Scenedesmus, figured below,—all Desmids.

As these all multiply by simply dividing into two,—and that frequently,—it will be understood that a colony is soon established if one or two specimens are introduced. Figs. 25, 26, 27 represent species of Diatoms, in which the plant is enclosed in tiny boxes of pure flint.

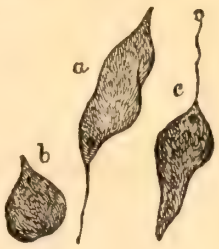

FIG. 20.

Euglena.

It will be well to obtain a few specimens of the brittle-stemmed Chara or Nitella, interesting on account of the peculiar protoplasmic movements in the cells. Fig. 28 shows a portion of Chara about the natural size.

FIG. 21.

Cosmarium.

FIG. 22.

Closterium.

Nor will our colony be wanting in representations of minute animal life. Multitudes of the remarkable Wheel Animals or Rotifers will glide through the water, their

FIG. 23.

Pediastrum.

FIG. 24.

Scenedesmus.

wheel-illusions in active work, drawing the smaller Monads to their mouths, and great will be our joy when we find specimens of that industrious rotifer Melicerta,

who spends a great part of his time in making little bricks, which he builds up round him until they form a

FIG. 25.

FIG. 26.

FIG. 27.

Diatoms.

circular tube, sticking out from the stem or leaf of a water-weed. Then there are the Vorticellæ or Bell-animalcules shown in Fig. 29. They are like Lilliputan wine-glasses set on ridiculously long flexible footstalks, which have a habit of suddenly coiling up, cork-screw shape, bringing the bell to the base from which the colony springs. We may have Stentor, and Vaginicola, and of larger forms the interesting Hydra and the Fresh-water Sponge. In fact, there is an almost endless variety of forms, both of animal and plant life, to reward the diligent microscopist.

FIG. 28.

Chara.

FIG. 29.

Vorticellæ.

A capital tank for microscopic organisms may be constructed out of a biscuit-tin (full size). From the back and front of this box a large piece of tin should be

cut, so as to leave a frame about three-quarters of an inch in width all round. This frame should be covered on the inner side with red-lead in which should be bedded a pane of glass, cut to the exact size of the front or back. The outside should now be painted a suitable colour, or what is better coated with Brunswick-black. All it now needs is to be mounted on a piece of board, and retained in position by four strips of wood fixed on by small brads. The tin can be most cleanly cut out with a pair of stout scissors,—if the lady of the house is not looking on. The biscuit-tin will cost one shilling, and the whole of the other materials,—glass, red-lead, Brunswick-black &c., will not exceed a similar amount. So that the microscopic aquarium need not cost more than a couple of shillings and a very small amount of labour.

CHAPTER VI.

THE MARINE AQUARIUM.

IT is impossible in the limits of a sixpenny hand-book to describe the management and stocking of a Marine Aquarium, in addition to the requisite information anent Fresh-water Aquaria. We hope to supplement this manual by a companion one devoted exclusively to the consideration of marine tanks, so that the few brief notes here offered must be accepted as suggestions only.

In the first place, it would be well to modify the structure recommended for the fresh-water tank. It is advisable in both fresh and salt-water tanks to offer as large a surface as possible to the revivifying influence of the air; but in the marine aquarium there is a greater necessity for this because of the salt water becoming vitiated more quickly than fresh water. So that the surface exposed to the air should be quite twice that of the glass front. In addition, there should be a constant circulation of water through the tanks, and this could be managed by the fountain and cistern arrangement shown in chapter I. But the fountain jet should not be quite so fine as that for fresh water. Any leaden pipes which may be used for this purpose, should be coated inside with shellac, dissolved in spirits of wine, to prevent the action of the salt water upon the metal with consequent

injury to the inhabitants. For the purposes of aeration some prefer an arrangement of pipes along the floor of the tank, connected with a pair of bellows, by means of which fine jets of air are forced through holes in the pipe, whence they rise through the water, purifying it as they go. But this plan necessitates constant attention, which is out of the question for business men. On the other hand, the fountain cisterns can be made large enough to hold sufficient water to supply the fountain for a day, and need no looking after. But the great agent to be relied upon for purification is the growths of confervoid algæ, of which the spores are certain to be introduced in the sea water with which we fill our tank. It is not advisable to introduce any grown specimens of sea-weeds, as in nearly every case such introduction would be attended with failure.

Having taken the trouble to procure a supply of water from the sea, or from one of the railway companies that now supply the larger towns with sea-water, we must mind that it is kept up to the natural density. It will be understood that from a large surface of water exposed to the air there is great evaporation, and the water thus lost flies off perfectly pure, leaving all its saline particles behind. Consequently the water in the tank, whilst decreasing in bulk, increases in density, so that if left alone it soon becomes a strong brine in which the animals will be pickled. To obviate this difficulty soft fresh water must be added, but in doing so care must be taken not to make the water too fresh. But the dealers in aquarium requisites supply what are known as "gravity-bulbs," of which there are two kinds. One is so weighted that it remains on the floor of the tank whilst the water is of the proper density, but should the latter get too salt

by evaporation the bulb rises to the surface. The other ordinarily floats on the surface, but sinks immediately that too much fresh water has been added. By the assistance of these little instruments the mean density can be easily maintained. And now for the inhabitants. The beginner would do well to try his hand with the lovely sea-anemones, of which so many species are to be obtained upon our coasts. One of the commonest and hardiest of these is the Beadlet (*Actinia mesembryanthemum*) to be obtained almost anywhere on the coast. As an instance of the hardihood of this species we may mention the case of "Granny," a specimen gathered more than fifty years ago by Sir John Dalyell from the rocks of North Berwick. This venerable Beadlet is still living in a prosperous and thriving condition. At the death of Sir John, it was handed over to the care of Prof. Fleming, and afterwards passed to the late Dr. M'Bain. He, on the prospect of death, was most solicitous to find a proper guardian for such a treasure. Some to whom he spoke declined to undertake so responsible a duty, till at last Mr. Sadler, the curator of the Royal Botanical Gardens at Edinburgh, cordially responded to the request, and when last heard of the old lady was doing well. She is not failing in her powers, in spite of her age, for we hear that between the 4th of March and the 4th of October, 1879, she gave birth to twenty-seven little beadlets, though this is a very small matter compared with a circumstance which occured in 1857. On one night in that year she produced no less than 240 young ones!

Many other species may be included, and to them may be added a number of Periwinkles, and a few other Molluscs, also Prawns, *serpulæ*, Starfish, &c. To these,

in the course of time, he will be able to add a few fish ; but it is well to start on a small scale and gradually add to our operations as our experience increases.

We stated our intention of giving merely an indication of the lines to be pursued and we shall keep that promise, reserving to a future work a more detailed description of the Marine Aquarium.

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